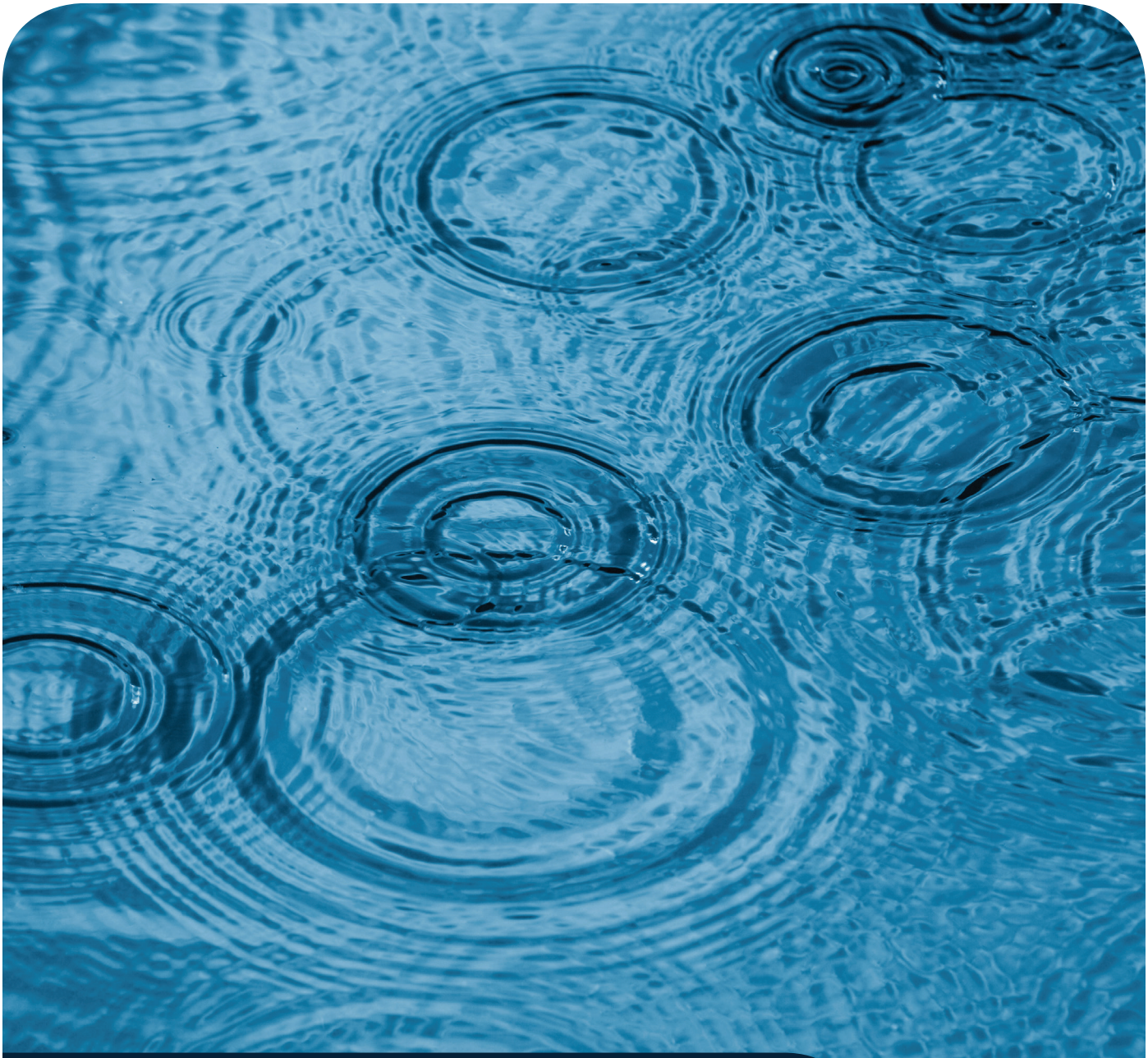


Rain to Drain
Slow the Flow

PennState Extension

NATIONAL PEER REVIEWED

Rain to Drain—Slow the Flow is a multi-dimensional journey following the movement of stormwater on Earth. The curriculum development was led by Jennifer Fetter, Watershed Youth Development Educator, Penn State Extension, in collaboration with the PA 4-H Youth Development Team, the Penn State Extension Renewable Natural Resources Team, and the Penn State Department of Landscape Architecture.

Special thanks and appreciation go to the following people who served on the development, review, editing, and pilot testing teams. This curriculum guide would not have been possible without them.

Kristen Kyler	Vincent Cotrone	Charles Andrew Cole
Sanford "Sandy" Smith	Bryan Swistock	James Clark
Deborah Dietrich	Ruth Benner	Susan Boser
Bradley Kunsman	Stuart Echols	Gary Micsky

Cover photo: Used with permission from istockphoto.com

Rain to Drain—Slow the Flow

This curriculum guide will lead you through the *Rain to Drain - Slow the Flow* 4-H experiment and additional activities.

What is 4-H?

4-H Is the largest youth development program in the United States. It is run by each state's land-grant university as part of their Cooperative Extension program, a partnership with the USDA, state, and local governments.

The 4-H mission is to empower youth to reach their full potential, working and learning in partnership with caring adults.

4-H Mission Mandates

The mission of 4-H is to provide meaningful opportunities for youth and adults to work together to create sustainable community change. This is accomplished within three primary content areas, or mission mandates: citizenship, healthy living, and science. The educational foundation of 4-H lies in these three mission mandates.

Citizenship

Since its inception, 4-H has placed emphasis on the importance of young people being engaged, well-informed citizens. By connecting to their communities and community leaders, youth understand their role in civic affairs and expand their role in decision-making processes. It's clear that civic engagement provides the foundation that helps youth understand the "big picture" of life and find purpose and meaning.

Healthy Living

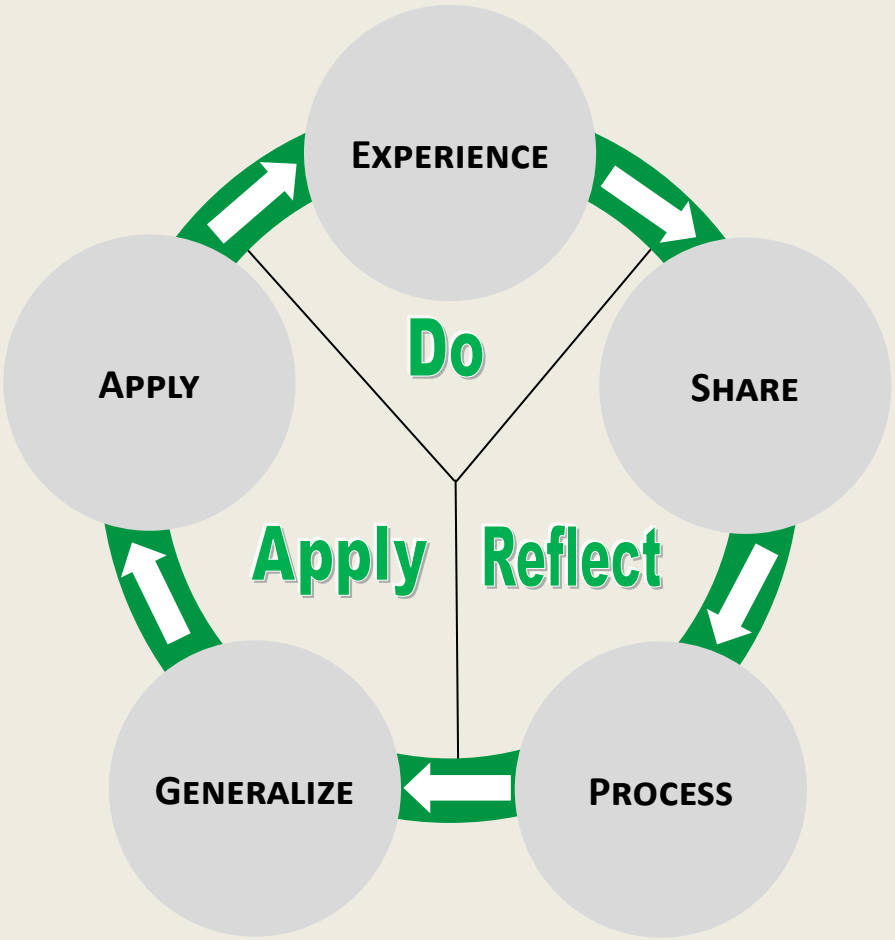
Healthy food and nutrition has been addressed by the program since its inception in 1902. Having a long history of promoting healthy living among youth and their families, 4-H has become a national leader in health-related education. The 4-H Healthy Living Mission Mandate engages youth and families through access and opportunities to achieve optimal physical, social, and emotional well-being.

Science

The need for science, engineering, and technology education is essential for today's young people. 4-H programs prepare youth for the challenges of the twenty-first century by engaging them in a process of discovery and exploration.

Excerpted from: USDA 4-H National Headquarters, 2011, *Fact Sheet —Mission Mandates*, Washington DC, viewed 19 June 2015, http://www.4-h.org/resource-library/curriculum/development/develop/.

The Experiential Learning Model



The activities in the *Rain to Drain—Slow the Flow* curriculum were written to emphasize the use of inquiry and the experiential learning model. The experiential learning model emphasizes the importance of youth being involved in each of the five stages of the model throughout their learning experiences. Youth **experience** the learning activity, **share** their experiences with others, **process** what was important about the experience, **generalize** how their experience relates to everyday experiences, and then **apply** the skills they gained to other parts of their lives. "Do, Reflect, and Apply" are ways to connect life skill development to any subject matter learning experiences.

The Cooperative State Research, Education and Extension Service developed the Experiential Learning Model and delivered it through *Curriculum Development for Issues Programming: A National Handbook for Extension Youth Development Professionals,* Washington, DC : CREES, 1992.

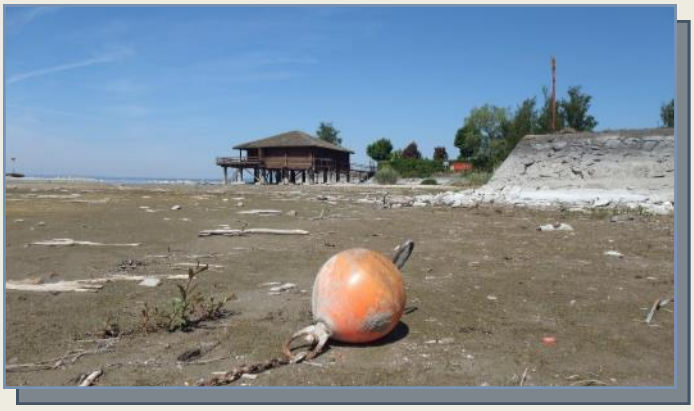
Introduction

Water is an incredibly important natural resource. We can't live without it. We not only need water for our own daily uses, like drinking and washing, we also need water for agriculture, manufacturing, and energy production—and lots of it. Water is found in many places and in many forms on Earth. As a liquid, we can find it in lakes, rivers, and underground aquifers. As a gas, it is drifting through our atmosphere. As a solid, it is frozen in glaciers and on snow-covered mountains.

Not Enough Water

In some parts of the United States water is abundant. It many places, however, water is becoming scarce. Perhaps you have experienced a time when you have had to use less water than normal because your community was experiencing a drought. There are a number of different causes that are contributing to the decrease of water supplies in those communities. No matter what the cause, the result is that water supplies are not able to replenish themselves through rain and snow as fast as people need to use them.

Water found beneath the Earth's surface, known as **groundwater**, has been decreasing rapidly in large parts of the United States in recent years. Nearly half of the US population gets its drinking water from groundwater supplies, including almost the entire rural population. Over 50 billion gallons of water used each day for agriculture also comes from groundwater. If groundwater supplies continue to get smaller, the impacts could affect many people.



"Groundwater Depletion." *USGS Water Science.* US Geological Survey, 17 Mar. 2014. Web. 6 July 2015.

Too Much Water

Sometimes an abundance of water can also cause problems. Sudden and heavy rains and snow melts can lead to flooding and erosion. When the water makes it way into streams and rivers, sometimes it is too much for the banks to handle. The streams and rivers then overflow into the streets and into homes and businesses and across agricultural lands. Floods can leave a path of destruction in their wake. Over the past 50 years, flooding has accounted for over $97 billion in damages and nearly 4,000 deaths in the United States.

"SHELDUS™ | Spatial Hazard Events and Losses Database for the United States." *SHELDUS™ | Spatial Hazard Events and Losses Database for the United States*. Web. 6 July 2015.
Photo Credit: https://commons.wikimedia.org/wiki/User:Dupondt

Using Science for Solutions

Understanding the science of how water moves can help us learn how to conserve the water resources that we have. Science can also help to prevent water from being an unnecessarily destructive force. Environmental engineers, landscape architects, and water authority managers, among many other scientists and professionals, are working hard at designing innovative solutions to these problems. They are helping communities find ways to use these solutions to plan current and future development of homes, businesses, and entire neighborhoods.

Your challenge in **Rain to Drain—Slow the Flow** is to master the science of how water moves and help to design a community where water moves into the ground, becoming a helpful resource instead of becoming a flood.

Let's Get Started: How Water Moves

Time Needed: 20 - 25 minutes

Materials Needed:

- A baking sheet, plastic tray, or other similar smooth, flat surface with a lip/raised edges all the way around
- A small cup of water
- A ruler
- A damp sponge

Leader Notes:
This introductory activity is best done by the youth in a group, but it could be a demonstration led by an adult or teen leader as well.

1. Lay your baking sheet or tray on a table in front of you. In a moment, you are going to pour your cup of water onto the tray.
2. Before you do that, let's make a prediction about how the water is going to move on the tray.

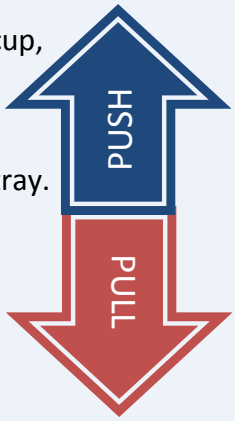
Describe what you expect to see on your tray after you pour the water onto it:

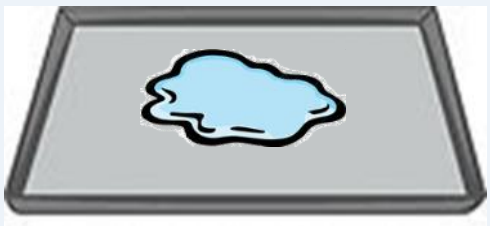
3. Now go ahead and pour the water out slowly and close to the tray. Was your prediction accurate?

Describe how the water looks on the tray:

According to **Newton's First Law of Motion**, "an object at rest will remain at rest and an object in motion will continue moving in a straight line unless compelled to change its state by the action of an external force."

In this case, the water is the "object" we are observing. By pouring the water out of the cup, we allowed the force of gravity to pull it down to the tray. The tray exerts an equal amount of force in the opposite direction, pushing the water against the force of gravity. These equal, or balanced, forces cause the water to rest in a puddle or droplets on your tray.





How can we get the water to start moving again?

In order to make an object at rest start moving, additional force has to be applied to it. **Forces** generally come in two categories, **push** and **pull**.

4. Can you think of some ways that we could push or pull the water to get it to move on the tray?

	Describe three ways you could move the water	**Is this a push or pull force?**
ex.	*push it with your finger*	*push*
1		
2		
3		

5. Try experimenting with one of your three ideas above. Were you able to get the water to move, and did the water move the way you expected it to?

Describe what you observed:

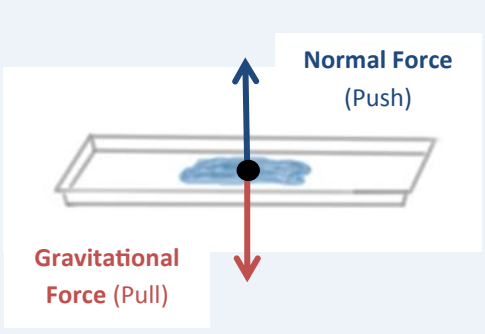
6. Let's try changing the slope of the tray and see what effect that has on the water. Raise the left edge of your tray off the table, just slightly, until you see the water start to move. (You may have tried this already as your force experiment above; try it again now and have the ruler ready.)

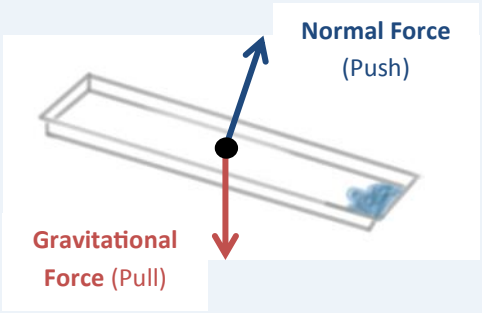
7. Using the ruler, measure how far off the table you had to lift the edge of your tray to get the water to move.

Which direction did the water move?

How high was the tray lifted off of the table?

By lifting the edge of the tray, you changed the angle of the tray's upward "push" force acting on the water. The force of the tray pushing up on the water is called the **normal force**. The **normal force** is a push force exerted perpendicular to any object or surface that another object comes in contact with. When you change the position of a surface, the direction of the normal force changes with it.

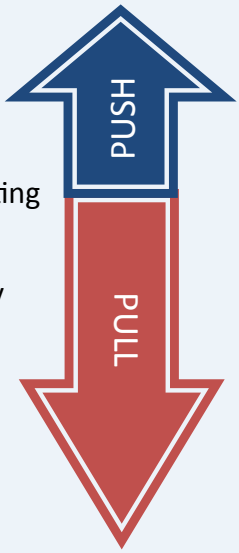




Gravity on Earth has an approximate value of 9.81 m/s^2, which means that the speed of an object falling freely near the Earth's surface will increase by about 9.81 meters (32.2 ft) per second every second.

Does water ever roll uphill without additional forces acting on it?

How can we slow or stop water from flowing downhill?



When more than one force acts on an object, the forces combine to form a **net force**. The combination of all the forces acting on an object is the net force.

When your tray is on an angle, the push of the normal force of the tray is not as strong as the pull force of gravity because it is now on an angle. They are unbalanced forces, and the resulting net force causes the water to be pulled downhill.

In order to get to net force closer to zero, you would need to add another force. We could try changing the friction. **Friction** is a force that is created whenever two surfaces move or try to move across each other. Friction always opposes the motion or attempted motion of one surface across another surface. You have been pouring water on a smooth tray, but what if you added a differently textured surface for the water to pass over or through?

8. Lay a damp sponge in the middle of your tray.
9. Tilt your tray to the same height you measured before.
10. Observe the movement of the water on the tray and compare it to water that encounters the sponge.

How did the sponge change the movement of the water downhill?

11. Think of some other surfaces you could place on the tray that might add friction, changing the flow of the water downhill.* Try them out.

Describe your observations:

**In addition to adding friction, the sponge is also absorbent and actually pulls some of the water up off of the tray.*

Connections to the Environment

Name a hard, smooth surface outside of your home or school that might act like the tray in our experiment:

Think of a time when it was raining and you saw water on that surface. Describe how the water moved on that surface:

Name a surface outside your home or school that might create friction and cause water to move more slowly:

Name a surface outdoors that is absorbent, like the sponge, and able to hold some of the water:

Repeat the last part of the experiment using natural materials you collect from outdoors.

Describe the materials you collected:

Describe how those materials changed the flow of water downhill:

Water is pushed and pulled on Earth constantly as it moves through the water cycle. Two important steps in the water cycle are evaporation and transpiration, known together as **evapotranspiration**. The sun's energy, with the aid of plants, draws water molecules up into the atmosphere.

Is evapotranspiration a **push** force or a **pull** force?